**Study Guide for CPE Equivalency Exam**

**Data and Variables**

**Terms to know:**

* Qualitative -Quantitative
* Observation -Inference
* Dependent variable -Independent variable
* Control -Scientific notation
* Accuracy -Precision
* Uncertainty -Significant digits

**Things you should be able to do:**

* Differentiate between, and classify, data as either qualitative or quantitative
* Distinguish between and identify the independent variable, dependent variable, and control in an experiment
* Given a set of data, create a good data table to organize the information
* Given a set of data, create a line graph that properly represents the data
* Analyze and interpret information presented in a graphic form
* Express numbers in standard form in scientific notation or express numbers in scientific notation in standard form
* Express answers from mathematical calculations to the appropriate number of significant digits

**Motion**

## Terms to know:

* Motion -Velocity
* Speed -Reference Frame
* Distance -Acceleration

**Equations you should be able to use:**

* speed = distance **/** time **s = d/t**
* acceleration = (final velocity – initial velocity) **/** time **a = (vf – vi) / t**

**Things you should be able to do:**

* Apply the speed and acceleration equations listed above in problem solving situations
* Rearrange the speed equation to solve for distance or time
* Rearrange the acceleration equation to solve for final velocity, initial velocity, or time
* Distinguish between speed and velocity
* Analyze distance vs. time graphs and interpret/describe the motion represented
* Sketch a distance vs. time graph for a given description of motion
* Given a distance vs. time graph, sketch or identify the corresponding velocity vs. time graph
* Analyze speed vs. time graphs and interpret the motion represented
* Sketch/identify a speed vs. time graph for a given description of motion
* Relate the slope of a distance vs. time graph to speed
* Relate the slope of a velocity vs. time graph to acceleration
* Compare the motion of two objects from an analysis of motion graphs
* Recognize and discuss three possible effects of acceleration

**Newton’s Laws & Forces Review**

**Terms:**

* Newton’ s 1st Law -Law of Conservation of Momentum
* Newton’s 2nd Law -action force
* Newton’s 3rd Law -reaction force
* gravity -vector
* free fall -inertia
* weight -resultant
* acceleration due to gravity (g) -projectile motion
* terminal velocity -momentum
* Newton -force
* balanced forces -unbalanced forces

**Equations:**

* Force = mass ***x***acceleration **(F=ma**)
* Weight = mass ***x*** acceleration due to gravity (**w = mg**)
* Momentum = mass ***x*** velocity (**p=mv**)
* Total momentum before a collision = total momentum after a collision
  + - * **p before = p after**(law of conservation of momentum)

**Things you should be able to do:**

* State all three of Newton’s Laws of Motion
* Apply Newton’s Laws to explain a variety of “real life” examples of force and motion (be able to do this with and without friction as a factor)
* Recognize that unbalanced forces cause accelerations
* Recognize that an object experiencing balanced forces may be at rest or moving with a constant velocity
* Describe the relationship between inertia and mass
* Recognize that a net force is the sum of all forces acting on an object
* Use Newton’s Second Law in problem solving situations (including the special case of weight)
* Differentiate between mass and weight
* Given mass, calculate weight
* Recognize that all forces exist as pairs
* Recognize that action-reaction pairs always act on two different objects at the same time
* Identify that action-reaction pairs act in opposite directions and with equal strength
* Explain the concept of free fall, with examples
* Describe/analyze projectile motion as the result of two independent motions – vertical and horizontal
* Use the momentum equation in problem solving situations
* Explain how momentum is conserved in a given situation
* Represent vector quantities in graphic form, using arrows
* Add vector quantities together
* Draw/interpret force diagrams (free body diagrams) for given examples of motion
* Recognize friction as a force that opposes motion (or the tendency of motion)

**Work, Power and Energy**

**Words you should know:**

* Work -Power
* Joules -Watts
* Potential energy -Kinetic energy
* Mechanical energy -Thermal energy
* Electromagnetic energy -Chemical energy
* Electrical energy -Efficiency
* Law of Conservation of Energy

**Formulas:**

* Work = force x distance (W = F x d)
* Power = Work / time (W/t)
* Gravitational Potential Energy = mass x free fall acceleration height (GPE = m g h)
* Kinetic energy = ½ x mass x velocity squared (KE = ½ mv2)
* Elastic Potential Energy = ½ x spring constant x displacement squared (EPE = ½ kx2)

**You should be able to:**

* Define/calculate work, including using the correct SI units
* Define/calculate power, including using the correct SI units
* Distinguish between situations where work is being done or no work is being done
* Explain the relationship between energy and work
* Calculate gravitational potential energy, including using the correct SI units
* Use gravitational potential energy to calculate mass and/or height of an object
* Calculate kinetic energy, including using the correct SI units
* Use kinetic energy to calculate mass and/or velocity of an object
* Calculate elastic potential energy, including using the correct SI units
* Use elastic potential energy to calculate the spring constant and/or displacement of an object
* Given a description of a process involving energy transformation, identify moments associated with maximum and minimum values of kinetic and potential energy
* Solve problems involving energy transfer and conservation requiring you to use multiple equations simultaneously (i.e. set two of the above energy equations equal to each other and solve)
* Identify/describe transformations of energy for a given situation including the work being done that causes the energy change to occur
* Trace a sequence of energy transformations for a given situation
* Distinguish between various types of energy (see list above)
* Explain the Law of Conservation of Energy and apply it to situations
* Discuss ways in which energy is “lost” from a system and how to minimize that loss
* Calculate power when provided with information on work (or force and distance) and time

**Heat and Temperature**

**Terms:**

* Temperature -absolute zero
* Heat -Kelvin
* Fahrenheit -Celsius
* Conduction -convection
* convection current -radiation
* conductor -insulator

**Things you should be able to:**

* define temperature according to the energy of molecules
* define heat
* differentiate between heat and temperature
* Define/give examples of convection, conduction and radiation
* Identify a given scenario as convection, conduction and/or radiation
* Identify and distinguish between conductors and insulators

**Waves**

**Terms**

* Wave - Crest
* Mechanical wave - Trough
* Electromagnetic wave - Compression
* Medium - Rarefaction
* Transverse - Amplitude
* Longitudinal - Wavelength
* Frequency - Period
* Interference - Audible Range
* Constructive Interference - Infrasonic
* Destructive Interference - Ultrasonic
* Pitch
* Reflection - Electromagnetic Spectrum
* Plane mirror (radio, microwave, infrared, visible light,
* Refraction ultraviolet, X-ray, gamma)

**Equations**

Frequency = 1/ Period (**f = 1 / T**)

Velocity of a wave = frequency x wavelength (**v = f x λ** )

Fundamental wavelength for an open ended tube = 2 x Length of tube (**λ = 2L)**

Fundamental wavelength for a closed ended tube = 4 x Length of tube (**λ= 4L)**

**Waves (continued)**

**Things you should be able to do**

* Define/discuss or analyze any of the terminology listed above
* Identify/Label the parts of transverse and longitudinal waves
* Given a graphic representation of a wave with amplitude and time data, be able to determine the frequency of the wave.
* Differentiate between mechanical and electromagnetic waves
* Explain and evaluate the relationship between frequency and wavelength for a given medium
* For changes in length, predict the effects on the pitch of sound produced by strings and air columns
* For changes in tension, predict the effects on the pitch of sound produced by strings
* Explain the differences in pitch resulting from identical lengths of open and closed ended pipes
* Properly sequence the types of radiation on the EM spectrum in terms of increasing or decreasing frequency, wavelength, or energy
* Solve problems involving the relationships described by the equations above
* Analyze the path of light as it refracts through a new material
* Identify angles of incidence and angles of reflection or refraction for situations where light is incident upon the boundary of two distinct media.
* Explain the law of reflection

**Properties of Matter**

**Terms**

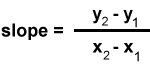
* Matter - Kinetic Theory
* Element - Solution
* Atom - Gas
* Compound - Solid
* Molecule - Liquid
* Pure Substance - Plasma
* Mixture - Evaporation
* Density - Condensation
* Physical Change - Sublimation
* Chemical Change - Melting
* Homogeneous - Boiling
* Heterogeneous - Freezing
* Suspension

- Endothermic

- Exothermic

**Equations**

Density = Mass / Volume (**D = m/V**, m = DV, V = m/D)



**= Rise/Run**

**Properties of Matter (continued)**

**Things you should be able to do**

* determine whether object will sink or float based upon density information
* identify phase changes as either endothermic or exothermic
* classify mixtures as homogeneous or heterogeneous and/or provide examples of each
* classify properties of matter as either physical or chemical and recognize examples of each
* classify changes in matter as either physical or chemical and recognize examples of each
* solve mathematical problems using the density equation
* explain the difference between states of matter in terms of the behavior of the particles that make them up
* interpret and analyze information presented in mass vs. volume graphs and determine density using the graph (find the slope)
* interpret and analyze change of phase information presented in a graphic form…this includes identifying temperatures at which change processes occur and identifying state of matter present for a given temperature
* explain, in terms of energy, what happens at the particle level to a substance absorbs heat and undergoes changes of phase

**Solubility**

**Terms**

* Solubility - Concentrated -Solvent
* Soluble - Dilute -Saturated
* Insoluble - Polar -Supersaturated
* Solution - Non-polar - Unsaturated
* Solute - Hydrogen Bonding -Concentrated

**Solubility continued…**

**Equations**

Concentration = (mass of solute / Volume of solvent) x 100

*Other arrangements:* {**C = (m/V) \* 100**, m = (C \* V) /100, V = (m/C )\* 100}

\*\*\* Don’t forget you can always set up problems as a proportion: m1 = m2

V 100 mL

**Things you should be able to do**

* Define/discuss the terms listed above
* Identify and explain how shaking a mixture can influence the dissolving process
* Identify and explain how heating a mixture can influence the dissolving process
* Identify and explain how breaking up the solute can influence the dissolving process
* Describe how water is capable of dissolving so many different solutes (what does it mean to be polar)
* Solve problems relating to concentration
* Interpret and analyze solubility information from a graph of **solubility vs. temperature**
  + - Determine amounts that can dissolve
    - Determine required temperatures for dissolving
    - Determine whether a given solution is saturated or unsaturated
* Recognize the difference between solids and gases with regard to the solubility/temperature relationship

**Atomic Structure and the Periodic Table**

**Terms**

Proton

Neutron Atomic Number

Electron Atomic Mass

Nucleus Periodic Table

Atom Family or Group

Isotope Period

Element Ion

Metal Electron Orbitals/Energy Levels

Non-metal Valence electron

Metalloid (semiconductor) Bohr model diagram

Lewis dot diagram (electron dot diagram)

**Formulas**

# of protons = atomic number

# of electrons = atomic number

# of neutrons (average) = Atomic mass rounded off – atomic number

**Things you should be able to do**

* Describe the contributions of the scientists, listed above, to our understanding of the structure of the atom and atomic theory
* Determine the number of particles in an atom from atomic number and atomic mass data found on a periodic table…specifically: the # of protons, the # of neutrons, and the # of electrons
* Compare and contrast isotopes of the same element (in terms of particle composition)
* Draw and interpret Bohr model diagrams for any element with an atomic number of 1 – 20.
* Draw and interpret Lewis diagrams for any representative element (Groups 1, 2, 13-18 on PT)
* Explain the organization of the periodic table in terms of electron arrangement
* Determine the number of valence electrons for an atom of a representative element based upon the column in PT
* Determine the number of energy levels used based upon row in the periodic table

**Chemical Bonding**

**Terms:**

* chemical formula - oxidation number
* ionic bond - valence electrons
* covalent bond - Lewis diagrams
* ion - reactants
* diatomic molecule - products
* polyatomic ion - balanced chemical equation
* subscript -coefficient

**Chemical Bonding (continued)**

**Things You Should Be Able To Do:**

* Determine the charge associated with ion formation of various elements; relate this to its position on the Periodic Table
* Determine the number of atoms of any element in a compound given the chemical formula
* Distinguish between what happens in an ionic and covalent bond
* Identify element combinations as either ionic or covalent
* Draw/interpret Lewis diagrams that represent ionic bonds
* Draw/interpret Lewis diagrams that represent covalent bonds
* Write chemical formulas for given combinations of elements and/or polyatomic ions (given elements, write the compound)
* Given a chemical formula, name simple ionic compounds (including ones containing polyatomic ions)
* Given a chemical formula, name covalent compounds
* Write a chemical formula given the compound name
* Balance chemical equations given the formulas

**Acids and Bases**

**Terms:**

* acid - salt
* base - pH
* electrolyte - hydronium ion
* indicator - hydroxide ion

**Formulas:**

A difference of 1 pH corresponds to a factor of 10 difference in hydronium concentration.

For example: pH of 3 is 10 times more concentrated than a pH of 4

pH of 3 is 10 x 10 (100) times more concentrated than a pH of 5

**Things you should be able to do:**

* Compare and contrast acids and bases.
* Use the pH scale in order to identify an acid, base, or neutral solution.
* Compare the concentrations of various solutions based upon pH data.
* Differentiate between “strong” and “weak” acids or bases
* Relate the concentration of an acid or base to the ability to be an electrolyte.
* Give examples of common household acids and bases
* Explain how acids and base neutralize each other and identify the products of such a reaction